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BIOLOGICAL EVALUATION OF OAK DIEBACK AND COULTER PINE MORTALITY, DESCANSO AND PALOMAR RANGER DISTRICTS, CLEVELAND NATIONAL FOREST

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ABSTRACT

Dead coast live oaks at Las Bancas were infested with a roundheaded borer and Armillaria root disease. Dead Coulter pines on Laguna Mountain and Mount Palomar had been attacked by western pine beetle and pine engravers. Annosus root disease was present at certain locales. In general, oak and pine mortality were probably driven by the current severe and prolonged drought in California. It is not possible to prevent drought caused mortality in the forest as a whole, however, high value oaks and pines can be deep watered, and the boles of high value pines can be sprayed with an insecticide to reduce the probability of successful bark beetle attack. Thinning pine stands should reduce future mortality, but thinning should not be done until precipitation increases and reduces the stress on the trees.

INTRODUCTION

The Cleveland National Forest requested a visit by Forest Pest Management personnel to evaluate two problems: extensive oak mortality on the Descanso Ranger District and extensive mortality in Coulter pine on Mt. Palomar. On April 10, 1991, Laura Merrill and John Kliejunas (FPM, San Francisco), George Gleason and Tom White (Cleveland National Forest -- Supervisor's Office), Debra Deppe (Descanso Ranger District), and Roger Wong (Palomar Ranger District), examined oaks on the Descanso Ranger District and pines on Laguna Mountain. On April 11, the above personnel with the exception of Tom White and the addition of Dennis Orbus (Palomar Ranger District) examined dying pines on Mt. Palomar.

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DESCANSO RANGER DISTRICT -- OAK DIEBACK

OBSERVATIONS

According to Forest personnel, oak mortality is extensive on the District and has affected live, black, and Engelmann oaks. Mortality appears to be heaviest on poorer sites, *e.g.*, where soil is thinnest. Some dead and dying coast live oaks, *Quercus agrifolia* Nee, were examined at Las Bancas (sec. 26, T.15 S., R.4 E.) near the community of Pine Valley. This area will be developed as a trailhead into the Pine Creek Wilderness and thus is being managed for recreation. In the past the area was used for grazing.

Some live oaks examined were suffering from branch mortality, while others were entirely dead. The following pests were observed in association with these trees:

Phymatodes lecontei Lins. (Coleoptera: Cerambycidae), a roundheaded borer

a leaf miner causing damage similar to *Lithocolletis agrifoliella* Braun (Lepidoptera: Gracilariidae)

a leaf tier causing damage similar to *Setiostoma fernaldella* Riley (Lepidoptera: Stenomidae)

Armillaria sp. on a root of an uprooted stump.

The Pacific oak twig girdler, *Agrilus angelicus* Horn (Coleoptera: Buprestidae) and oak pit scales, *Asterolecanium* spp. (Homoptera: Asterolecaniidae), were not found.

PEST BIOLOGIES

Phymatodes lecontei Lins. and Minor Oak Defoliators

P. lecontei are small (8 - 15 mm long), plain brown to black longhorned beetles. Antennae are almost as long as the body, and the femurs are distinctively enlarged. There is a photograph of a related and similar appearing beetle on p. 304 of *Western Forest Insects* (Furniss and Carolin 1977).

P. lecontei occurs in *Quercus agrifolia, Q. lobata,* and *Q. garryana* on the Pacific Coast of North America from British Columbia to southern California. Adults fly in June, and larvae feed in branches and boles which are dead or dying; thus this insect is not a primary pest. Adults of this species may be a nuisance, but not damaging, when they emerge from oak firewood brought into dwellings (Linsley 1964).

The lepidopterous leaf tiers, whose larvae tie 2 - 4 leaves together with silk and feed between them, and leaf miners, whose larvae mine individual leaves, observed at Las Bancas cause minimal damage to the trees. It would be extremely unusual for these insects in nature to reach population sizes

necessary to cause significant defoliation. These insects are discussed by Brown and Eads (1965).

Armillaria Root Disease

Armillaria sp. is widely distributed in soils and usually lives as a saprophyte on dead wood or other organic matter. This fungus has a wide host range, including virtually all woody plants in California. It is frequently associated with hardwood roots, especially oaks. Healthy oaks are resistant to the fungus. This resistance disappears, however, when trees are weakened, stressed, cut, or killed, and *Armillaria* sp. may then rapidly colonize and decompose roots and sometimes entire root systems. Stresses that have been linked to increased damage from this root disease include insect defoliation, drought, excessive soil moisture, poor planting techniques, bark beetle attack, air pollution injury, and nutrient deficiencies.

The organic material used as a source of nutrition is called a food base. With a large food base to utilize, the fungus becomes more aggressive and moves to the roots of nearby trees by means of root contacts and rhizomorphs. Rhizomorphs are structures that resemble black shoestrings and grow like roots through upper soil layers. The predominant method of tree to tree spread in California is via root contact; rhizomorphs are more important and prevalent in other areas of the country.

Armillaria sp. is capable of directly penetrating through the intact root bark of living trees and once it reaches the cambium it usually grows rapidly, producing a flat, white, leathery, fan-shaped mycelial mat. Rhizomorphs are often associated with the mat. If the fungus reaches the root collar it girdles the stem and kills the tree. After *Armillaria* sp. successfully colonizes a root segment or root system, it continues to decay the wood and causes a white to yellowish, wet, stringy rot. This rot does not usually extend more than a few feet above the soil line.

Clusters of mushrooms may be found in the fall at the base of infected dead or dying trees and stumps. These mushrooms may also grow directly out of the soil near the food base. Spores produced by fruiting bodies are not an important source of new infections or long distance spread.

MANAGEMENT ALTERNATIVES

1. **No action:** Oaks will continue to die until precipitation increases. Dead oaks and other vegetation may constitute a fire threat to residences and other structures. However, dead oaks may also provide wildlife habitat.

2. **Salvage:** Removal of accessible dead oaks would reduce fuel buildup, but would not affect populations of the pests seen. Emergence of *P. lecontei* adults from firewood may cause some concern among the public.

3. **Water high value trees:** Deep watering of specimen trees, such as in campgrounds, every 2 to 3 months will enhance their growth and survival. Surface sprinkling increases the susceptibility of native oaks to Armillaria root disease and should be avoided.

4. **Direct control:** Phymatodes lecontei is a secondary pest, thus direct control will not prevent oak mortality. Armillaria sp. is probably ubiquitous in the oak woodlands, and it is neither possible nor perhaps desirable to attempt to eradicate it over large areas.

LAGUNA RECREATION AREA

We briefly examined dead Coulter pines in the Laguna Recreation Area. Mortality appeared to be associated with pockets of overstocked pines and drought stress. There was evidence of western pine beetle (Dendroctonus brevicomis LeC.), pine engravers (Ips spp.), pocket gophers, annosus root disease, and dwarf mistletoe.

Biologies of these pests and management alternatives will be discussed in the following section.

PALOMAR RANGER DISTRICT -- COULTER PINE MORTALITY

OBSERVATIONS

We visited the East Grade of Mt. Palomar, where most of the land is in private ownership. Overstory Coulter pines, Pinus coulteri, in this vicinity are 80 - 120 years old. Forest personnel estimate that 70% of these Coulters are dead. Big cone Douglas-fir, Pseudotsuga macrocarpa, also grow in this area and do not appear to be suffering mortality. Portions of the stand which are within the Forest boundaries are being managed for visual values. Buildup of fuel from Coulter mortality and the heavy growth of brush is a grave concern.

Some dead Coulter pines were examined for pests in a 12 acre unit in Sec. 20, T. 10 S., R. 2 E. The western pine beetle, Dendroctonus brevicomis (Coleoptera: Scolytidae), and an unidentified roundheaded borer (Coleoptera: Cerambycidae) were found. A live Coulter had branch dieback caused by engraver beetles (Coleoptera: Scolytidae).

We also stopped briefly at two other sites: (1) Observatory Campground, which contains some large old Coulter pines which had not yet been attacked by beetles. The Forest may treat these trees with a protective spray; and (2) on private land on Mt. Palomar (Mother's Kitchen) large diameter white firs were observed with annosus root disease and fir engravers (Scolytus ventralis LeC [Coleoptera: Scolytidae]).

PEST BIOLOGIES

Western Pine Beetle

The western pine beetle, Dendroctonus brevicomis, breeds in the main bole of living ponderosa and Coulter pine larger than about 4 inches dbh. Normally it breeds in trees weakened by drought, overstocking, root disease, dwarf mistletoe or fire.

Adult beetles emerge and attack trees continuously from spring through fall. Depending on the latitude and elevation, there can be from one to four generations per year. The generations are difficult to distinguish because the prolonged period of initial attack and re-emergence of parent females to establish additional broods causes considerable overlapping of the generations.

Initial attacks are made about mid-bole and subsequent attacks fill in above and below. Pheromones released during a successful attack attract other western pine beetles. Attacking beetles may spill over onto nearby apparently healthy trees and overwhelm them by sheer numbers. Pitch tubes and red boring dust are indications of successful attacks.

Adults bore a sinuous gallery pattern in the cambium and the female lays eggs in niches along the sides. The larvae feed in the inner bark for a short distance and then turn into the outer bark to complete development.

Bluestain fungi introduced during successful attacks probably contribute to the rapid mortality associated with bark beetle attacks.

Woodpeckers, predaceous beetles and low winter temperatures cause natural control. Silvicultural activities that result in rapid, vigorous tree growth increases tree resistance and prevents mortality. Individual high value trees undergoing a temporary reversible stress, such as drought, can be protected for up to a year by applying insecticides to the bole.

Pine Engraver Beetles

Pine engraver, Ips spp., attacks have been recorded on most species of pines in California. These beetles kill saplings, poles and sawtimber up to about 26 inches dbh and the tops of even larger trees. Attacks on live trees are usually limited to trees which are suppressed, or stressed by dwarf mistletoe, root disease, drought, fire or the attack of other insects. If fresh slash is available in the spring, pine engravers may build up in an area and cause localized mortality or top killing by mid-summer.

Attacks are made with the coming of warm weather in the spring. Attacking males bore nuptial chambers in the inner bark and release a pheromone which attracts other beetles to the attack site. If many beetles are attracted, they may attack nearby trees and cause a group kill. Within a day or two of the attack by the male, two to five females enter the nuptial chamber and after mating, each female bores an individual egg gallery which lightly scores the sapwood. The size and pattern of the combined gallery pattern is often diagnostic of the species of Ips involved. The galleries are kept open by beetles pushing boring dust out through the entrance hole. Red boring dust collecting in bark crevices or spider webs is diagnostic of a successful attack. Eggs are laid in niches along the sides of the galleries. Larvae hatch from the eggs and feed in the phloem. They eventually pupate in cells at the end of their larval mines and transform to adults.

A new generation is produced in as little as 6-8 weeks in the spring to 4-6 weeks in mid-summer (August). Thus, several overlapping generations per year

may be produced. The winter may be passed in any of the life stages of larvae, pupae, or adults, depending upon which Ips species is involved.

Outbreaks in standing, healthy trees are sporadic and of short duration, and are often associated with some temporary stress or shock afflicting the host species, such as drought or logging disturbance. Tree killing frequently occurs where green pine slash, which serves as breeding habitat is left untreated during spring and summer. To be suitable as pine engraver breeding habitat, pine slash must have bark from 1/8 to 1 inch thick (usually 3 to 26 inches diameter), must have succulent cambium and must remain moderately cool during the development period.

Fresh pine slash caused by thinning, dwarf mistletoe control work, construction or winter storm breakage can be modified in a number of ways to make it unsuitable for pine engraver breeding. One approach to minimizing damage is to schedule slash-generating activities mostly between mid-July and late-December, when the slash has a high probability of drying out, heating up, or spoiling before the beetles can complete their development. Utilization of the cut material to the smallest possible diameter will minimize the amount of breeding material available to engraver beetles. If green pine slash must be created during the sring and early summer, slash treatments are available to prevent the buildup of pine engraver populations. Because pine engravers can complete their development in about a month under ideal conditions, treatment should be carried out soon after cutting to be effective.

Slash treatment methods which generally work well include chipping, lopping and scattering slash in sunny areas to heat it up, crushing or mashing slash with logging equipment to make it unsuitable for pine engraver breeding, or piling and burning the slash within a month of cutting. Broadcast burning the slash might work if it could be done without damaging the residual stand. A method which has worked during the summer in hot climates is to pile slash in a sunny area and tightly cover the pile with clear plastic. If the temperature under the bark of slash in all parts of the pile reaches 120^{o}F, all brood currently in the pile will be killed. Lower temperatures will not be effective and, where successful, this method will not prevent reinfestation of slash piles. Because most pine engraver attacks occur within a quarter-mile from the location where the beetles emerged, high value pines can be given some protection by removing fresh pine slash to areas which do not have pines.

Two practices which should generally be avoided are piling fresh pine slash without further treatment, and allowing slash to touch or remain near valuable leave trees.

Annosus Root Disease Biology And Impact

Heterobasidion annosum is a fungus that attacks a wide variety of woody plants. All western conifer species are susceptible. Madrone (Arbutus menziesii), and a few brush species (Arctostaphylos spp. and Artemisia tridenta) are occasional hosts. Other hardwood species are apparently not infected. The disease has been reported on all the National Forests in California, with incidence particularly high on true fir in northern

California, in the eastside pine type forests, and in southern California recreation areas.

Annosus root disease is one of the most important conifer diseases in the Region. Current estimates are that the disease infests about 2 million acres of commercial forest land in California, resulting in an annual volume loss of 19 million cubic feet. Other potential impacts of the disease include: increased susceptibility of infected trees to attack by bark beetles, mortality of infected trees presently on the site, the loss of the site for future production, and in recreation areas, depletion of vegetative cover and increased probability of tree failure and hazard.

During periods favorable to the fungus, fruiting bodies (conks) form in decayed stumps, under the bark of dead trees, or under the duff at the root collar. New infection centers are initiated when airborne spores produced by the conks land and grow on freshly cut stump surfaces. Infection in true fir may also occur through fire and mechanical wounds or occasionally, through roots of stumps in the absence of surface colonization. The fungus grows down the stump into the roots and then spreads via root contacts into the root systems of adjacent live trees, resulting in the formation of enlarging disease centers. These infection centers may continue to enlarge until they reach barriers, such as openings in the stand or groups of resistant plants. In pines, the fungus grows through root cambial tissue to the root crown where it girdles and kills the tree. In true fir and other non-resinous species, the fungus sometimes kills trees, but more frequently is confined to the heartwood and inner sapwood of the larger roots. It then eventually extends into the heartwood of the lower trunk and causes chronic decay and growth loss.

Heterobasidion annosum in western North America consists of two intersterility groups, or biological species, the 'S' group and the 'P' group. These two biological species of H. annosum have major differences in host specificity. All isolates of H. annosum from naturally infected ponderosa pine, Jeffrey pine, sugar pine, Coulter pine, incense-cedar, western juniper, pinyon, and manzanita have, to date, been of the 'P' group. Isolates from true fir and giant sequoia have been of the "S" group. This host specificity is not apparent in isolates from stumps, with the 'S' group being recovered from both pine and true fir stumps. These data suggest that infection of host trees is specific, but saprophytic colonization of stumps is not. The fungus may survive in infected roots or stumps for many years. Young conifers established near these stumps often die shortly after their roots contact infected roots in the soil.

Western Dwarf Mistletoe

Dwarf mistletoes (Arceuthobium spp.) are parasitic, flowering plants that can only survive on living conifers in the Pinaceae. They obtain most of their nutrients and all of their water and minerals from their hosts. Western dwarf mistletoe (A. campylopodum) infects principally ponderosa, Jeffrey, and knobcone pines, and occasionally Coulter and lodgepole pines.

Dwarf mistletoes spread by means of seed. In the fall the fruit ripen and fall from the aerial shoots. The seeds are forcibly discharged. The seed is

covered with a sticky substance and adheres to whatever it contacts. When a seed lands in a host tree crown, it usually sticks to a needle or twig, where it remains throughout the winter. The following spring the seed germinates and penetrates the twig at the base of the needle. For the next 2-4 years, the parasite grows within the host tissues, developing a root-like system within the inner bark and outer sapwood, and causing the twig or branch to swell. Aerial shoots then develop and bear seed in another 2-4 years.

Dispersal of dwarf mistletoe seeds is limited to the distance the seeds travel after being discharged. From overstory to understory, this is usually 20 to 60 feet, but wind may carry them as far as 100 feet from the source. A rule of thumb is that the seeds can travel a horizontal distance equal to the height of the highest plant in an infected tree. There is some evidence that long distance spread of dwarf mistletoe is occasionally vectored by birds and animals.

Vertical spread within tree crowns of most dwarf mistletoes is limited to less than one foot per year because of foliage density. Because of the thin crowns of Digger pine, however, the vertical rate of spread has been measured as being greater than 2 feet per year. This rate of spread equalled or exceeded the rate of height growth of infected trees.

Dwarf mistletoes are easy to identify because they are generally exposed to view within a tree's crown. Signs of infection include the yellow-green to orange mistletoe plants, basal cups on a branch or stem where the plants were attached, and detached plants on the ground beneath an infected tree. Symptoms include spindle-shaped branch swellings, witches' brooms in the lower crown, and bole swellings.

MANAGEMENT ALTERNATIVES

1. **No action:** It is possible that the drought and bark beetles have thinned the forest sufficiently to significantly increase the amount of moisture available to the remaining live trees. However, it is more likely that mortality will continue until most or all of the overmature Coulter pines are dead, or until after the current drought is ended. The presence of large quantities of dead trees and brush is a significant fire hazard.

2. **Salvage:** Forest personnel intend to salvage accessible trees, crush the brush, and use prescribed burning to reduce the fuel load. Inaccessible trees will be left for wildlife. These actions will not directly affect the pest populations, but will result in a more fire resistent and healthy forest. The large amount of mortality on adjacent private land will continue to present a fire hazard.

3. **Thin:** The Forest has done extensive thinning on the Laguna Recreation Area and, more recently, in some stands on the Palomar Ranger District. Further thinning of these stands and thinning of previously unthinned stands would reduce future damage. Treatment of all freshly-cut conifer stumps to prevent infection by _H. annosum_ in recreation sites is directed (FSM 2305.14, R-5

Supplement 164). Since thinning itself may cause stress to the leave trees, it should be delayed until after precipitation returns to higher levels.

4. **Protection of individual trees:** Individual high value trees may be sprayed on the boles to reduce the likelyhood of successful attacks by bark beetles. Forest personnel expressed interest in doing this is the Observatory Campground, where there are several large, old Coulter pines near recent bark-beetle caused mortality. Similarly, high value trees can be deep watered a few times during the year to increase their survivability.

5. **Direct control:** Direct control of bark beetles (felling and treating infested trees to prevent emergence of brood) has not been shown scientifically to prevent further tree mortality. It would be extremely difficult to fell all the infested trees on public and private lands on Mt. Palomar because of the high numbers of such trees and the inaccessibility of many of them.

LITERATURE CITED

Brown, L.R., and C.O. Eads. 1965. A technical study of insects affecting the oak tree in southern California. Berkeley: Calif. Agric. Exp. Stn. Bull. 810. 105 pp.

Furniss, R.L., and V.M. Carolin. 1977. Western Forest Insects. Washington, D.C.: U.S. Dept. Agric., Forest Service, Misc. Pub. No. 1339. 654 pp.

Linsley, E.G. 1964. The Cerambycidae of North America. Part V. Taxonomy and classification of the subfamily Cerambycinae, tribes Callichromini through Ancylocerini. Univ. of California Publications in Entomology 22: 1-197.